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**TRANSPORT SYSTEMS RESEARCH VEHICLE COLOR
DISPLAY SYSTEM OPERATIONS MANUAL**

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Summary

Installation of the new color display system in the Advanced Transport Operating Systems (ATOPS) Transport Systems Research Vehicle (TSRV) at NASA Langley Research Center required an intense effort lasting approximately 2 years. Complete rework of the Research Flight Deck was required. Individuals with technical expertise in the fields of electronics hardware, mechanical design, high-speed data interfaces, specialized software, and flight wiring were involved.

Important features of the new color display system were to be operational ease and minimal maintenance. While generally these features were realized, any system this complex will always require specialized knowledge for full utilization in a constantly changing research environment. However, first line maintenance, routine flight operations, and system level troubleshooting of malfunctions can be performed by persons without detailed knowledge of the display system engineering design. It is for these individuals that this operations manual is written.

Troubleshooting techniques and procedures are covered in the main body of the manual. A quick reference guide is contained in the appendices for use in routine operations.

Procedures for installation and configuration control of software are included. However, technical details of both software generation and hardware design are omitted from the operations manual.

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At the NASA Langley Research Center, the Transport Systems Research Vehicle (TSRV) used for flight testing in the Advanced Transport Operating Systems (ATOPS) program has recently completed a major upgrade in which a color display system was installed. The display system consists of eight ARINC-D size CRT displays in the Research Flight Deck (RFD) and a complex system of microprocessors and cable interconnections to generate varied software-controlled display formats for research flight testing.

In addition, a smaller display system with fewer display units but identical in function was installed in the ATOPS Experimental Avionics Systems Integration Laboratory (EASILY). This facility operates independently of and in parallel with the flight system and allows continuous software development without interference to flight operations.

Installation of these two systems along with development of effective methods of operation, maintenance, and configuration control required a 2-year effort by a team of specialists in various technical and management areas. The result is a flight research system which is quite versatile but which requires specialized knowledge and experience to fully utilize its capabilities in an ever-changing research environment.

As part of the required documentation, this operations manual has been prepared to facilitate use of the system by persons with only general familiarity. The appendices contain quick reference information for routine operation, while the main body presents a more detailed configuration and troubleshooting guide.

2.0

List of Abbreviations

ACD	Analysis and Computation Division
ADIRS	Air Data Inertial Reference System
AST	AST Research Corporation
ASCB	Aircraft Standard Communications Bus
ATOPS	Advanced Transport Operating Systems
ATL	Active Task List
BIU	Bus Interface Unit
COM 1	Communications Port 1 of PC
COM 2	Communications Port 2 of PC
CR	Carriage Return
CRT	Cathode Ray Tube
CSC	Computer Sciences Corporation
DATA C	Digital Autonomous Terminal Access Communication
DEC	Digital Equipment Corporation
DEU	Display Electronics Unit
DMA	Direct Memory Access
DOS	Disk Operating System
DP	Display Processor
DSPFST	Display Fast Routine in Host Computer
DSPHDL	Display Handler in Host Computer
DU	Display Unit
EASILY	Experimental Avionics Simulation and Integration Laboratory

EEPROM	Electronically Erasable Programmable Read Only Memory
EFSS	Experimental Flight Systems Section
ENG	Engine Display
FMS	Flight Management System
H	Hexadecimal Number
IEEE-488	Institute of Electrical and Electronic Engineers Standard Number 488
INS	Inertial Navigation System
I/O	Input/Output
LRU	Line Replaceable Unit
ND	Navigation Display
PC	Personal Computer
PC-VT	VT-100 Terminal Emulation PC Software
PFD	Primary Flight Display
RFD	Research Flight Deck
RS-232	Serial Communication Standard
SBU	Switch Buffer Unit
SCP	System Control Panel
SYS	System Warning Display
TERMX	Terminal Software for Host Computer
TSRV	Transport Systems Research Vehicle
VT-100	Terminal for Norden Host Computer
WX	Weather Radar
XON/XOFF	Software Handshake Mode for Serial Communication Interface

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3.0

TSRV Color Display System General Description

The TSRV color display system general interconnection diagram is shown in figure 1. The system contains eight Display Units (DU's) located in the RFD (Figure 2) and two identical units located at the display pallet (Figure 3). Each RFD unit has a bezel panel mounted around the face. Three Display Electronics Units (DEU's) are located in the lower left portion of the display pallet. These each contain four microprocessors (80186) three of which can each generate one DU format while the fourth one handles I/O. A table summarizing the specific function of each processor is contained in Appendix B. The Bus Interface Unit (BIU) is located in the Aft Cargo Bay of the aircraft on the Norden computer rack. It contains a microprocessor identical to those in the DEU's and is used to convert parallel DMA data to serial data which is then placed on the ASCB serial bus for input to all DEU's.

The Sperry PC located at the display pallet (Figure 3) serves as a terminal for the microprocessors using the System Control Panel (SCP) software. It also serves as a terminal for the host Norden computer using PC-VT, a software package for VT-100 emulation. The SCP interface is by means of an IEEE-488 bus and VT-100 emulation uses an RS-232 interface (PC COM 2). A serial printer is used on the other RS-232 port of the PC (COM 1).

Each of the Display Units at the top of the display rack may repeat any one of the eight units in the RFD. Selection is accomplished via the Switch Buffer Unit (SBU) located under the PC keyboard. Also, the SBU is used to select the display formats repeated at each research station on monochrome X-Y repeaters. The repeater interface units located near the lower right of the display rack are used to convert color information to monochrome and drive the signal cables connected to monochrome repeater inputs (X, Y, and Z).

At the extreme lower right of the display rack is the discrete switching panel for the RFD Display Units. It is used to select one of four formats which can be presented on each DU in the RFD.

The full flight configuration of the color display system, including the Norden host computer and its two disk drives, contains a total of 46 individual LRU's (EASILY units not included) and about 3200 wire connections.

Also the normal flight PC disk set consists of:

SCP DISK:

System Control Panel for terminal interaction with the Display DEU microprocessors.

MON/CONFIG DISK:

Interface PC software which controls communication between the SCP and the DEU microprocessors.

PC-VT DISK:

PC software for VT-100 emulation.

FORMAT AND I/O DISK:

Contains Input/Output and Format software to be loaded into the DEU microprocessor memory.

TEST FORMAT DISK (DIAGNOSTIC):

A special diagnostic program to be loaded into the DEU microprocessor memory for checking processor functioning and I/O paths.

SINGLE DRIVE SCP PLUS MON/CONFIG DISK:

A disk containing the minimum required SCP and MON/CONFIG files. It is for use in case one PC disk drive is not operating.

PC-WRITE WORKING DISK:

Text editor for real-time generation and/or changing of command files for use with the SCP. It will be useful for generation of partial system configuration files if one or more processors or LRU's become inoperative.

DOS DISK WITH UTILITIES:

MS-DOS with file handling and disk format utilities.

BACK UP OF ALL THE ABOVE:

Readily available backup disks in case one or more of the prime disks become unusable.

SCRATCH DISKS:

Spare blank disks for general use.

These prime and backup disks are stored in the same box on the aircraft due to space limitations and should not be removed without the knowledge and approval of personnel directly responsible for display configuration control. It is a good idea for these personnel to keep a readily available copy of them in a personal file.

4.0 TSRV Color Display System Operating Procedure

4.1 General:

The RFD DU's should be removed and replaced using extreme care and in general this is a task to be performed only by those individuals directly responsible for the display system. Especially important is the fact that EACH BEZEL PANEL HAS 110 VOLTS IN THE CONNECTOR. PULLING THE CORRESPONDING DU BREAKER DOES NOT TERMINATE THIS POWER AND ELECTRICAL SHOCK CAN RESULT. Also the bezel connector can be damaged easily if proper care is not used. When removing a unit it is best to terminate power to the entire display system via the master switch described below.

4.2 System Power Up:

The entire display system (RFD, Pallet, and X-Y Repeaters) is activated by the master toggle switch at the lower left of the display pallet on the power panel. After the main switches at the Flight Management System (FMS) Pallet are on, this switch should be turned on and the operator should verify (after about 30 seconds) that all display units and X-Y repeaters are lighted. Color purity will not be good initially but should gradually improve during the first 10 minutes of operation.

When the Nordens are turned on at the FMS pallet, sensible display formats should appear on all DU's. If not, the DATAC switch on the FMS pallet should be verified to be on, or resident software should be checked in the Norden computers and/or the display microprocessors (See discussions that follow). After the system is turned on, temperature checks should be made every half hour or so, especially if air conditioning is not operating. The thermal alert system readout is located at the top left of the display pallet and it cycles through all thermocouple locations.

(See thermal alert system operations manual.) A chart listing all thermocouple locations is positioned below the temperature readout. If any of the upstairs locations, 12 through 24, exceed 50 degrees C, the corresponding unit should be turned off and the problem investigated. Channel 22, DEU 1, is probably the most critical and should be watched especially carefully when ambient cabin temperature is above 28 degrees C. If a DU begins to overheat it will degrade in performance and shut itself down before destruction. The first indication will be failure to produce raster. Thus, if raster is not present on a DU that normally has it, a temperature check should be made immediately or the unit powered down for further investigation.

Individual units may be turned off by pulling breakers on the display power panel; but, if an over temperature condition exists, the entire system probably should be turned off and the responsible individuals alerted.

4.3 Terminal and Host Configuration:

Under normal conditions, no memory loading for the display microprocessors is required and the Sperry PC will be used as a Norden terminal by loading PC-VT which uses COM 2 of the PC. To install PC-VT, place the disk labeled PC-VT in drive A of the PC and boot normally (CTL ALT DEL). PC-VT will auto load after modes for printer configuration are installed. (The printer is configured at 1200 baud, 8 data bits, no parity, 1 stop bit, XON/XOFF, COM 1.) The DOS and PC-VT on the disk are configured to set all this on boot-up; thus, the screen prompts should be followed. When PC-VT is on line, VT-100 functions are available and operation is almost identical to the other terminals on board.

If Norden software must be installed, the tasks to run (after PC-VT is active) are DSPHDL and DSPFST. Type ATL from the terminal system prompt to see if these tasks are active. If present and not running properly, they may be aborted and run again. Use ABO TASKNAME (DSPHDL, DSPFST, etc.) to abort. Then type RUN TASKNAME to reinstall. When DSPFST is called (RUN DSPFST), answering of the prompts will depend upon the display processor software configuration. Software authors or those responsible for configuration control will know this. A configuration may be created at will as long as the DSPFST entries are compatible with the DP formats. For the baseline flight configuration, the assignments are:

Nav Processor #1: DP12 DEU 1, Display Processor 2.
Nav Processor #2: DP32 DEU 3, Display Processor 2.
Nav Processor #3: DP00 No NAV #3 Format Used.
Nav Processor #4: DP00 No NAV #4 Format Used.
NASA PFD Processor: DP11 DEU 1, Display Processor 1.

To Use TERMX type RUN TERMX and respond properly to the baud rate prompt. Normally a carriage return <CR> will suffice since the PC-VT software is already configured for 1200 baud. Using TERMX here is the same as for all VT-100 units. Enter H to obtain assistance if needed. Use Control Z to exit TERMX. If PC-VT needs to be reconfigured, follow the menu available on bootup.

If the PC is INOP or in use for internal display terminal functions (SCP), the VT-100 at the FMS pallet can be borrowed via a switch behind the FMS rack.

4.4 Display Microprocessor Loading:

A total of 13 display processors must at one time or another be loaded in the BIU and DEU's. This is a very time-consuming, though not difficult, process that will normally be done by those responsible for display configuration control. However, the procedure is given in case anyone else needs to perform it.

4.4.1 System Control Panel:

Load the SCP software by placing the disk labeled SCP in drive A of the PC and booting. Autoload will result after printer configuration.

4.4.2 Set System Configuration:

Place the PC in CAPS LOCK and insert the disk labeled MON/CONFIG in drive B. Then type B:IW13 if all 13 processors are active. Allow approximately 3 minutes during which time SCP commands will be scrolling up the monitor screen. If one or more DEU's or individual processors are missing, configuration requires a little more effort since individual configuration files must be created for each case, and combinations can become burdensome with 13 processors to be dealt with. However, if the BIU is not operating no configuring will be of value since the NORDEN data will never reach a display processor. Certain configuration files for use when one or more entire DEU's is missing have been prepared and are on the MON/CONFIG disk. Files for missing or INOP individual processors in one or more DEU's have not been prepared.

If those cases are encountered, the individuals responsible for display maintenance and configuration control should be consulted.

4.4.2.1 Missing DEU System Configuration:

The system for using existent configuration files for missing DEU's is as follows:

From the SCP with the MON/CONFIG disk in drive B, call configuration file B:IWDmn where m and n are DEU numbers present in the system. For example, if only DEU1 is on line, the file will be B:IWD1; if DEU's 1 and 3 are there, the file will be B:IWD13. If the necessary file has not been previously prepared (individual processors INOP), it can be created with an editor. PC-Write is present on a normal display disk, but EDLIN, Wordstar, AED1T, etc., may be used. Modification and renaming of an existent file is recommended with care being used not to overwrite the original file.

Any files so created should be written to the MON/CONFIG disk, but for experimentation one should create a scratch directory on this disk for storage of new files. To ensure compatibility with the SCP, these files must have at least one Control Z at the end and must not contain any blank lines even at the end of the file. They also must have .CMF extensions and must in turn call a file with .CF extensions. Thus, two files must be edited.

Any time power is removed from a DEU or BIU, it must be reconfigured before the terminal (SCP) can be used.

Various additional files are on the MON/CONFIG disk in directory MISC. These files were used during system debugging and will generally be of use only to those responsible for maintenance.

4.4.3 I/O and Display Format Loading:

After the processors are configured, loading I/O and DISPLAY FORMAT software can occur. EEPROM write discrettes must be set for each processor before loading. Use the function keys listed in the lower left menu area on the SCP screen. The F7 key cycles through the list if your prompt is not there. If this does not work, type TEST and try again. Use the space bar between function key selections for the next menu prompt. For discrete setting press SET DISCRETES function keys in turn. The prompt for the target must be answered with the DP# to be loaded. Its EEPROM write discrettes are on the chart attached to the PC and are listed in Appendix B, the QUICK REFERENCE CHART.

After proper discrete setting, use LOAD VERIFY and enter target and filename (PATH) as prompted. The disk in drive B must now contain formats and/or I/O files (PFDCK.CIM, NAVCK.CIM, DP01.CIM, DP4.CIM, etc.) not the MON/CONFIG disk. The format and I/O disks are part of the normal flight set. In response to the PATH prompt, type B:FILENAME with FILENAME obtained from the list in Appendix B, QUICK REFERENCE CHART. BIU files should always be loaded into DP01 and DP4 files should be loaded into DP14, 24, and 34. The format generation Display Processors may be loaded with any format chosen from the list in Appendix B or supplied by individuals controlling specific tests. All such FILENAMES have the extension CIM which does not have to be typed into the SCP as this is the default case.

4.4.4 Loading and EEPROM Discrete Reset:

After proper configuration of the command line, <CR> is pressed and the selected processor status on the top of the SCP screen will change to MONTR and a horizontal bar graduated in percent values will appear in the lower right.

Allow approximately 45 seconds for the next response which will be a decrease in length in discrete increments of the horizontal percent bar. All one can do is wait for about 4 minutes or so until the percent scale is gone indicating that loading is complete. Then, using function keys from the SCP menu, set discretetes to 1FF (Read only) and reset the processor using the SCP RESET menu selection. This same process must be repeated for all processors to be loaded using proper write discretetes. The process is quite slow for several reasons: (1) EEPROM is being programmed which is a much slower process than writing to RAM, (2) The load files are in INTEL HEX and must be converted to binary by the SCP loading software, and (3) The load files are rather large (approximately 45 to 65 kilobytes).

4.4.5 Command Files For Loading Enhancement:

Experienced persons will likely create command files to aid the load process, and several of these files are on the FORMAT disk and are described in Appendix B. These command files are composed of pre-written SCP commands and take care of all discrete setting, processor resetting, etc., for complete loading. Simply call these files by name from the SCP with the proper FORMAT disk in drive B of the PC. They must be updated with an editor if any software configuration change is made, a task that will require the attention of those responsible for configuration control.

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5.0 Procedures to be Followed in Preparation
for Experiment Test Flights

1. Turn on the Display System and Norden computers as discussed previously in section 4.2 "System Power Up."
2. Load the current version of the host software and any required display formats and I/O software.
3. Load PC-VT into the Sperry PC and run the required host tasks, DSPFST and DSPHDL. See section 4.3 "Terminal and Host Configuration."
4. Activate TERMX. Call S1 (SETUP 1) to locate checksum information for all Display Processors. S1 contains three pages, one for the processors in each DEU. Compare the checksum readings with appropriate checksum values on the label of the flight format disk. Any disagreement probably indicates a need to reload one or more display processors and proper responsible individuals should be consulted. If all checksums agree, enter the required values on the flight configuration sheet. Software version numbers are also listed on the format disk label.
5. Check operation of all bezel buttons on PFD, NAV, and SYS displays. Only the bezel buttons on the pilot's PFD respond, but each NAV format should be independent. Set the map scale to 80 and select the Weather Radar function (WX), and verify proper functioning of the test pattern.
6. Check SBU operation by selecting all displays in turn on the repeater DU's at the display pallet. Also perform the same check for the monochrome X-Y repeaters.
7. Check brightness control units in the RFD overhead panel to verify proper operation regarding both display unit and bezel.
8. Leave the display system on for support of NAV, Flight Control, and Video preflight checks.
9. When finished, turn system off via the master power switch on the display pallet power panel. Make the required entries in the display system log book. Clean all CRT screens using the cleaning solution stored at the display pallet. CAUTION: FOR WIPING USE CHEESECLOTH ONLY, NEVER KIMWIPES OR OTHER ABRASIVE MATERIAL.

10. PREPARATION FOR TAXI: Leave system off until all power switching is completed. Then turn it on again with the master switch and boot PC-VT for flight. Remove the PC-VT disk from drive A and place a scratch disk in both drives and close the drive doors for flight.
11. CAUTION: Be sure the display system is turned off during all basic aircraft power switching. Use the master switch previously described for this.

6.0 Troubleshooting

1. PROBLEM:

Display unit(s) blank

POSSIBLE CAUSES:

Corresponding breaker not engaged; Brightness turned too low; Power panel or wiring problem; Unit totally INOP.

CORRECTIVE ACTION:

Check appropriate breakers, brightness control setting; select "STARS" pattern on discrete selection unit at display pallet. If no light, try another DU.

2. PROBLEM:

Display unit(s) display red X

POSSIBLE CAUSES:

Processor driving format not turned on or improper DEU software in memory.

CORRECTIVE ACTION:

Check DEU breakers, verify checksum of pertinent DEU format and reload if incorrect, load SCP plus configure file and reset processor, reload DP4 into DEU in question, reload BIU I/O software.

3. PROBLEM:

Display unit(s) and/or bezels too dim

POSSIBLE CAUSES:

Brightness control unit not properly set.

CORRECTIVE ACTION:

Check Brightness control setting. Increase if incorrect.

4. PROBLEM:

Bezel buttons do not work.

POSSIBLE CAUSES:

Bad bezel connection; Improper DP assignment in DSPFST; Bezels not supposed to work on that DU; e.g., Engine Display, Co-pilot's PFD.

CORRECTIVE ACTION:

Check Bezel connector; rerun DSPFST from terminal; check bezel words in TERMX, S3 to see if signal is getting to Norden.

5. PROBLEM:

DU formats frozen, red X's on Engine display, SYS display partially blank, MAPFAIL message on map.

POSSIBLE CAUSES:

Data I/O problem; BIU INOP, display Norden not receiving or shipping fresh data, variable COLDSL in display Norden set to 1.

CORRECTIVE ACTION:

Verify that Norden is not hung up and that BIU is on; reset COLDSL to 0 if it is 1; check BIU error reporting variables through TERMX, S2; load SCP plus CONFIG file and reset BIU; reload BIU software.

6. PROBLEM:

PFD pitch map black, other formats OK:

POSSIBLE CAUSES:

ADIRS attitude valids not present.

CORRECTIVE ACTION:

Verify that the ADIRS units are on; Call variable IATTV from TERMX and verify that it is not zero. If it is zero, and ADIRS is on, check the same variable in the Flight Management Computer. If it is 1, verify that host computers are in RUN, not HOLD or IC.

7. PROBLEM:

PC Disks not Readable:

POSSIBLE CAUSES:

Disk drive problem; Damaged disk.

CORRECTIVE ACTION:

Try backup disk, use known good disk to check drive; if drive is bad, PC must be removed for drive replacement. The VT-100 at FMS may be switched to the display Norden for shared use if PC is INOP. No SCP in this case.

8. PROBLEM:

Sperry PC INOP:

POSSIBLE CAUSES:

Many possible internal electronic computer failures.

CORRECTIVE ACTION:

Remove PC and replace it with EASILY unit or try cards or drives from other Sperry PC's available in EFSS. Spare IEEE and AST cards are available in the display cabinet in the EASILY. For interim aircraft operation share the VT-100 at FMS (switch at FMS Pallet). If a DP needs loading, carry it into EASILY, perform loading as described in Section 4.4 "Display Microprocessor Loading," and return unit to aircraft.

9. DEU DP FAILURE:

If a DEU DP fails, its format on the corresponding DU (see chart on PC) will likely show a red X. Suspected DP's can be checked via the SCP. If one will not respond to CONFIG attempts, try B:GET_DEUn from the MON/CONFIG disk. If this does not work, interchange two DEU's and try again to see if the problem goes with the processor or is in the slot. All DEU's will function in any slot and the same is true for DU's.

However, each DEU slot and the DU slots controlled from it are uniquely hard wired. Thus, care should be exercised if DEU connectors are interchanged and should, if possible, be done only by those responsible for display configuration control. In any case, detailed records must be kept when this type of change is made.

10. BIU PROBLEMS

BIU problems should in general be similar to those of the DEU's except for the DMA interface. A spare DMA interface card is in the Display parts cabinet in the EASILY. The only spare BIU is in EASILY, but it can be directly installed in the flight system.

11. GENERAL

An overall system diagnostic program "TEST" is available as part of the normal display PC disk set. It is loaded like any other format into whichever processor is desired. This software is very effective in testing the health of all system interfaces and is especially useful in checking the bezel panel hardware. To use it, place the TEST FORMAT disk in PC drive B with the SCP disk in drive A. Boot if the SCP is not already in memory, and follow directions in section 4.4 "Display Microprocessor Loading." Command files executable from the SCP are present on the TEST disk if all 13 processors or any one DEU must receive this software. These file names are LOADTEST if all processors are involved, or LOADTSTn where n is the DEU number to be loaded. Boot the system test disk into the host computer, and run HDL and SYSTEST.

12. BEZEL PANEL CONSIDERATIONS

The bezel panels are likely to cause considerable maintenance problems due to their fragile mechanical construction and electrical connections. In-house rework of the connectors has improved operation, but various problems still occur intermittently.

Producing legend marking tags has proven extremely difficult due to close dimensional tolerances required. Hand cutting the tags from stiff photographic print material is the only realistic method available at present and is very tedious and time consuming. Great care is necessary to avoid breaking the fragile retaining clips on the bezel switches. In summary, no short term solution to the bezel problem has been found. However, with proper care and constant attention, they will be usable for experimental flight operations until decisions are made regarding alternate display control panels.

7.0 Hardware Configuration Control

Hardware configuration control will consist of maintaining, to the best extent possible, a LRU in each slot for each flight. However, failures are likely from time to time and various partial system configurations will be required. Except for the Norden and BIU, sufficient spare LRU's exist for configuration of a flyable system under most conditions. Cognizant individuals responsible for display maintenance and configuration control will have to work these details real time, based upon circumstances and their knowledge of the system functions.

Except in extremely simple cases, software diagnostics and specially created configuration files will be required for isolation of hardware problems. This is again a task area requiring real-time diagnostic efforts by specific individuals responsible for display system maintenance.

8.0 EASILY Display System

The EASILY color display system is a scaled down configuration of the flight system. Only four DU's are present with two DEU's, normally DEU 2 and DEU 3 with slots uniquely hard wired as in the TSRV. A BIU is present with host interfacing the same as the TSRV except for use of a DEC PDP 11/84. SCP use and DP loading are the same as in the TSRV. PC-VT is not normally used if a VT-100 is available. No X-Y monochrome repeaters are used. Any flight LRU may be exchanged with an EASILY unit of like type. Additional slots are available for use in troubleshooting flight LRU's when necessary.

A DEU may be brought from the aircraft and loaded for flight use if the aircraft PC is INOP.

Configuration of flight software is not maintained for the EASILY system as its prime function is development and testing. It is used by software authors and EFSS personnel. Hardware configuration and maintenance are done by those who perform like functions for the flight system.

Disks with all current flight software should be kept in EASILY for emergency TSRV use.

9.0 Concluding Remarks

The recent upgrade of the TSRV has resulted in an all-glass RFD panel containing eight ARINC-D size CRT displays. A complex system of hardware and software has been configured to support these displays in a versatile flight research mode. An identical display system with fewer units has been installed in the EASILY facility for dedicated development and testing.

To the greatest extent possible, ease of operation and maintenance have been incorporated into these systems. Hardware reliability is greatly improved over the previous TSRV research display system and this should free key technical individuals for other tasks. Software is the key to versatile use and will continue to be the area demanding the most detailed technical design expertise. Complete documentation is needed to cover the many details involved in operation and maintenance of these two complex systems. This document is intended to serve as a single source of quick reference information needed for routine operation and system level maintenance. Detailed technical reference manuals will require additional effort by specific individuals who designed and configured the system.

APPENDIX A

Software Considerations

The process of bringing display software to the TSRV is described in the following sections.

A.1 Software Generation:

Software is developed by ACD and CSC personnel in response to requirements from experimenters, EFSS operations personnel, and ATOPS management. A combination of assembly and high-level language is used. For host software, compiling and assembly is accomplished mostly on the Cyber in ACD. For the display processors, a development system on the IBM PC is used. PLM and 80186 assembly are the languages used. Technical details of the software are contained in documentation generated by the software developers.

A.2 Software Delivery:

Host computer software delivery to EFSS is accomplished in the same manner as in the past and is described in pertinent documents.

Display processor software is delivered on IBM floppy disks with all source files, task build utilities, and load files included.

A.3 Task Building:

Host computer task building methods were not changed with the use of the color display system and are described in existing documentation.

For the display processors, the task building steps are described in the following paragraph.

On the IBM PC in the EASILY a working directory is created on the hard disk and a delivered floppy containing source files, include files, and utilities is copied into it. Then from the existent directory INTEL, the DOS commands UDI is entered. This activates the development system. Then the delivered command file ASSEMBLE is called to completely build the required load file for the display processor whose source is in the working directory. This ASSEMBLE file contains all the commands necessary to build a loadable CIM file including compiling, assembling, linking, locating, and converting to Intel Hex.

One half hour should be allowed for this building task. The resulting CIM file is operated on with the delivered utility GAP written in BASIC which fills unused memory locations with values that allow a consistently computed checksum of the load file after it is resident in the display processor memory. This checksum is used to verify that desired software is loaded at any given time. After use of GAP, it is a good idea to run the CIM file through a filter to strip Control Z characters from the end. The program FILER on the EASILY IBM PC is useful for this, or a suitable text editor (not Wordstar!) may be used. The total building process requires about 45 minutes for each format.

The CIM file resulting from these operations is the newly created load module to be tested and flown. It should be loaded and its checksum checked against that of the delivered CIM file. If the two do not agree, a problem exists and the task building should be repeated. Extremely reliable results have been obtained with the described method, however, and disagreement in checksum value is not expected.

A.4 Configuration Control:

Only files built by the above-described process are allowed to be flown. Tracking and control are done by EFSS and each flight configuration sheet is approved only after verification that accepted and tested software is resident in display processor memory. (See section 5.0 which describes preflight procedures.)

Also, as part of configuration control and tracking, the files resulting from the above-described task building (CIM file, MAP files and delivered SOURCE and COMMAND files) are archived on the PC, using PKARC, and the resulting ARC file is uploaded via LARCNET (FLINK) to the PDP-11 for storage in account EASILY/DISP, [302,57]. A README.DOC file is added before archiving and contains version number, date, checksum and other information needed for future use of the software. Each format has a separate ARC file as do the SCP, MON/CONFIG, PC-VT, and UTILITIES packages. Each ARC file contains a header comment listing version and date and reminding the user to consult the README.DOC file. To recreate a load file, the corresponding ARC file is retrieved to a PC disk using the LARCNET FLINK command. The ARC file is then expanded using PKXARC and the load file (CIM file) is copied for use.

In the case of SCP.ARC and PCVT.ARC a self loading flight disk may be created by downloading its corresponding ARC file, expanding it with PKXARC, and transferring the resulting files to a PC disk formatted with DOS 3.1 system. Earlier DOS versions should be avoided when working with the Sperry PC.

The same process applies for creation of a MONCFG.ARC disk except the formatted disk does not require DOS.

Specific names for resulting load files and the display processors to load them into are listed in Appendix B, "Quick Reference Chart."

APPENDIX B

Quick Reference Charts

B.0 Display Processor (DP) numbering scheme:

DEU's are numbered as DEU 1, DEU 2, and DEU 3. Within each DEU are four Display Processors, 1 through 4. The Display Processor numbers are then DPnm where n is the DEU number and m is the processor number within the DEU. For example DP11 is processor 1 in DEU 1, and DP34 is processor 4 in DEU 3. DPn4 always serves as an I/O processor and never generates a format. The single processor in the BIU has number DP01.

B.1 EEPROM Write Discretes and DP/DU interconnection:

DP's 1, 2, and 3 in each DEU are responsible for producing one format and driving one primary DU. However each DP is wired to auxiliary inputs of several more DU's on which the format can be displayed by local selection at the DU. The discrete switching panel at the lower right of the display pallet is used for this selection. Bezel switch functions are not transferred by this format selection technique since they are assigned through DSPFST in the host computer. The following table lists EEPROM write discretes and interconnection information for each display processor:

DP Number	Write Discrete	Host DEU	Prime DU Driven	Other DU's Connected
01	13F	None(BIU)	N/A(I/O)	N/A
11	13F	1	1	2,3,7,8
12	17E	1	2	1,4,7,8
13	17D	1	3	4,5,6
14	17B	1	N/A(I/O)	N/A
21	13F	2	4	3
22	17E	2	6	5
23	17D	2	None(WX)	None
24	17B	2	N/A(I/O)	N/A
31	13F	3	7	1,2,5,8
32	17E	3	8	1,2,6,7
33	17D	3	5	3,4,6
34	17B	3	N/A(I/O)	N/A

In all cases the EEPROM READ ONLY discrete is 1FF.

Note that DP01 and DPn3 are I/O handlers and do not directly produce formats. Also DP23 is reserved for synthetic weather radar (WX) and does not produce a format.

B.2 Processor assignments for use in DSPFST in the host computer. (See section 4.3 "Terminal and Host Configuration.")

Nav Processor #1: DP12
Nav Processor #2: DP32
Nav Processor #3: DP00
Nav Processor #4: DP00
NASA PFD Processor: DP11

B.3 Typical Format files and Display Processors into which they are loaded:

DP01: DP01.CIM (BIU)
DP14: DP4.CIM
DP24: DP4.CIM
DP34: DP4.CIM
DP11: PFDCK.CIM
DP12: NAVCK.CIM
DP13: ENGCK.CIM
DP21: SPFDCK.CIM (DELIVERED SPERRY PFD)
DP22: SPFDCK.CIM (DELIVERED SPERRY PFD)
DP23: DP23CK.CIM (SYNTHETIC WX)
DP31: PFDCK.CIM
DP32: NAVCK.CIM
DP33: SYSCK.CIM

The extension (.CIM) is not required when typing the path into the SCP.

B.4 Existing command files on the FORMAT disk for loading full system or individual DEU's. See section 4.4.5 "Command Files for Loading Enhancement."

DISPLOAD -- Loads all 13 processors (about one half hour)
LOADBIU -- Loads BIU (DP01)
LOADDP4 -- Loads I/O processors in all 3 DEU's
LOADDEU1 -- Loads 3 DP processors in DEU 1
LOADDEU2 -- Loads 3 DP processors in DEU 2
LOADDEU3 -- Loads 3 DP processors in DEU 3

TSRV DISPLAY SYSTEM BLOCK DIAGRAM

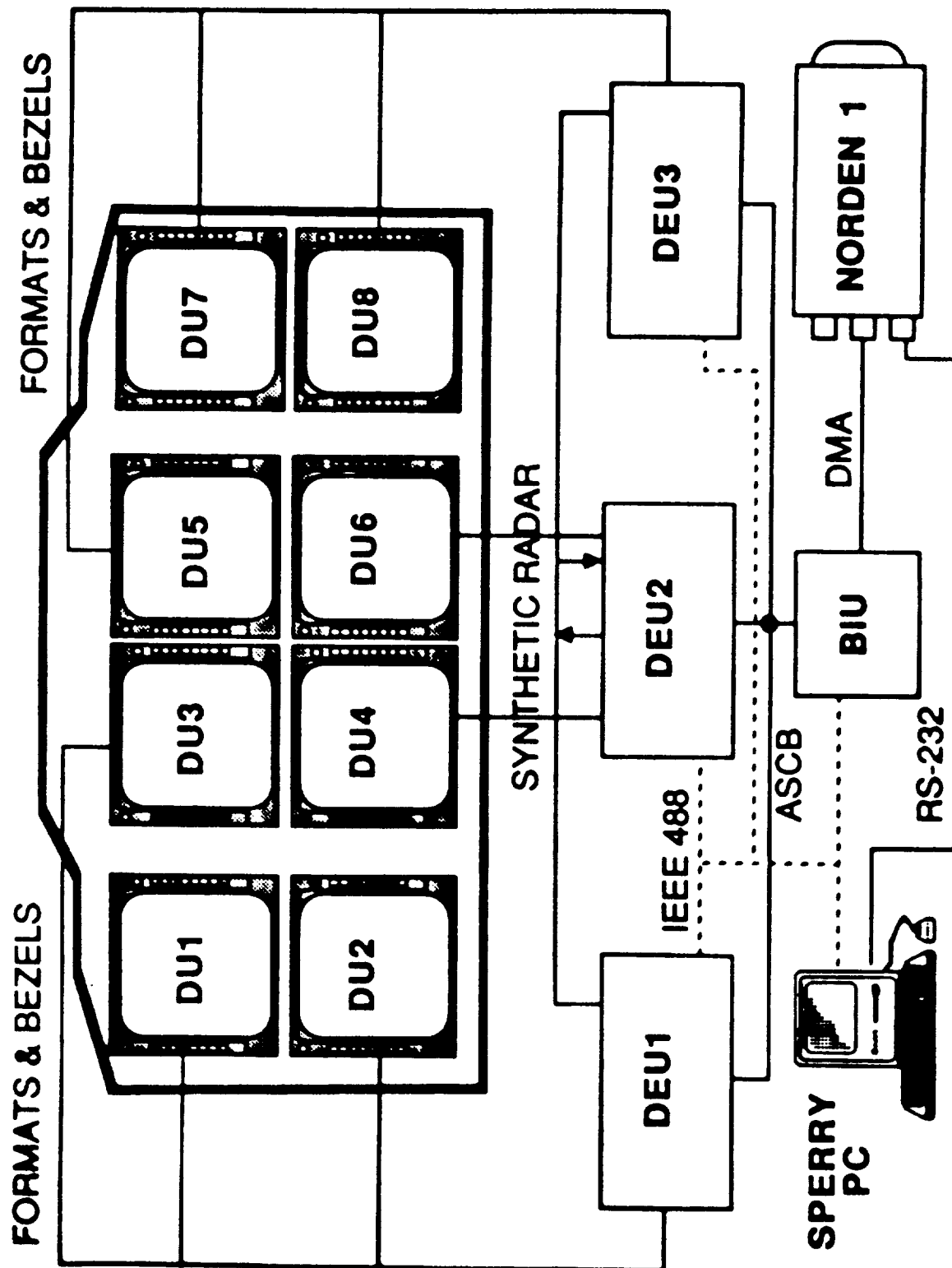


Figure 1. Display System Block Diagram

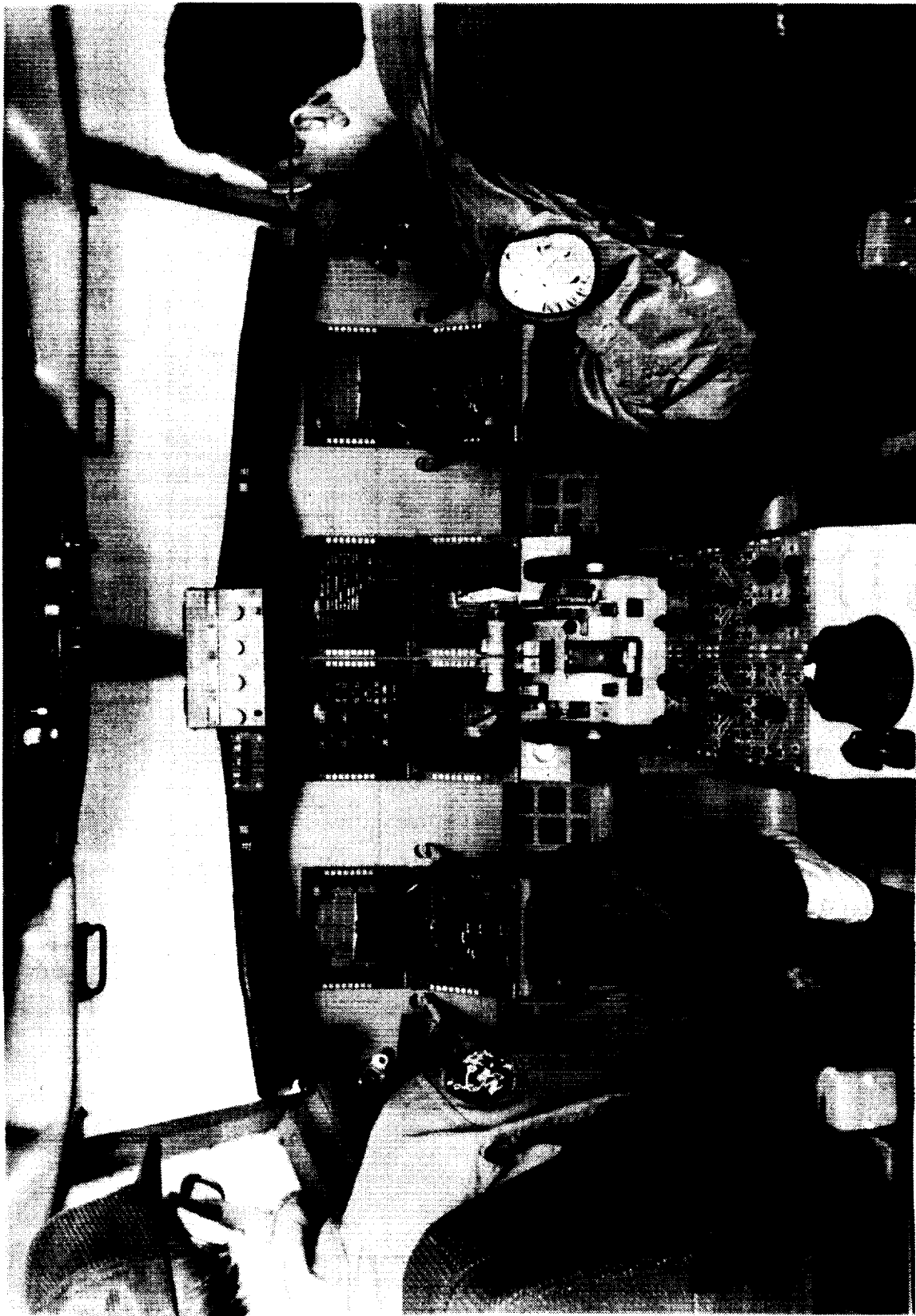


Figure 2. TSRV RESEARCH FLIGHT DECK

Liquid Crystal Display
Lithium-Ion Battery

01-03643

NASA

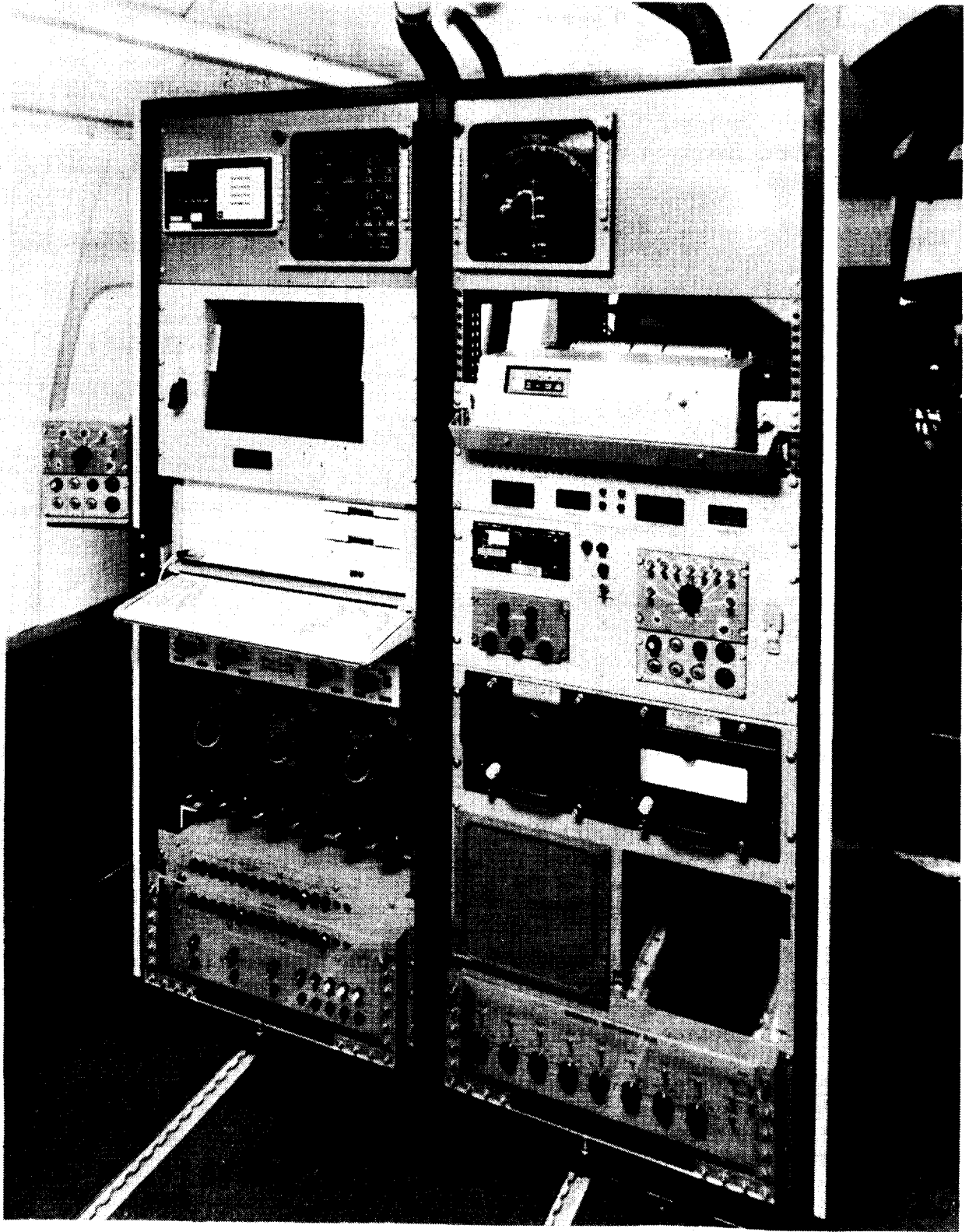


Figure 3. TSRV FLIGHT DISPLAY RACK

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Report Documentation Page

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16. Abstract A recent upgrade of the Transport Systems Research Vehicle operated by the Advanced Transport Operating Systems Program Office at the NASA Langley Research Center has resulted in an all-glass panel in the research flight deck. Eight ARINC-D size CRT color displays make up the panel. A major goal of the display upgrade effort was ease of operation and maintenance of the hardware while maintaining versatility needed for flight research. Software is the key to this required versatility and will be the area demanding the most detailed technical design expertise. This document is intended to serve as a single source of quick reference information needed for routine operation and system level maintenance. Detailed maintenance and modification of the display system will require specific design documentation and must be accomplished by individuals with specialized knowledge and experience.			
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